Greater Everglades Amphibians Model Requirements Document

INPUTS

Three types of input data layers are required to run each model scenario:

Hydro-period

The hydro-period is measured as the the number of days of inundation (water depth > 5cm) per hydrological year (June 1st of current year to May 31st of following year). This layer will be created from water depths produced by the ATLSS High Resolution Hydrology application which converts the South Florida Water Management Model (SFWMM) hydrological outputs from a 2 mile by 2 mile grid to a 500m grid cell resolution. The data will be in raster format and contain contiguous time steps and measured in units of meters or centimeters.

Vegetation

The input dataset for each scenario is a raster with each cell coded to represent a type of vegetation. The only generic requirement of this input data is that the grid cells and projection correspond to the water depth input data.

The specific vegetation input data that are being used were developed by Drs. Steve Friedman and Leonard Pearlstine of the National Park Service. A Geographic Information System was used to condense 60 vegetation classification scheme into 9 major habitat types: Cypress, Hammock, Mangrove, Pineland, Marsh/Rocky Glades, Slough, Borrow Pit/Canal, Building/Road and Dwarf Cypress Prairie over 500m grids.

Salinity

The salinity component period will be measured as a yearly average of daily salinity inputs. These input data will be in raster format that details contiguous time steps using a 500m resolution, and measured in Parts Per Thousand (PPT). The salinity inputs was produced by the Tides and Inflows in the Mangroves of the Everglades (TIME) model. The geographic extent of this data will overlap the land cover data but only south of the Tamiami Trail.

SCENARIOS

Initial model outputs will be generated for base scenarios of changes in sea levels and their effects on salinity and hydrology. Alternative scenarios will be modeled as alternative plans are identified.

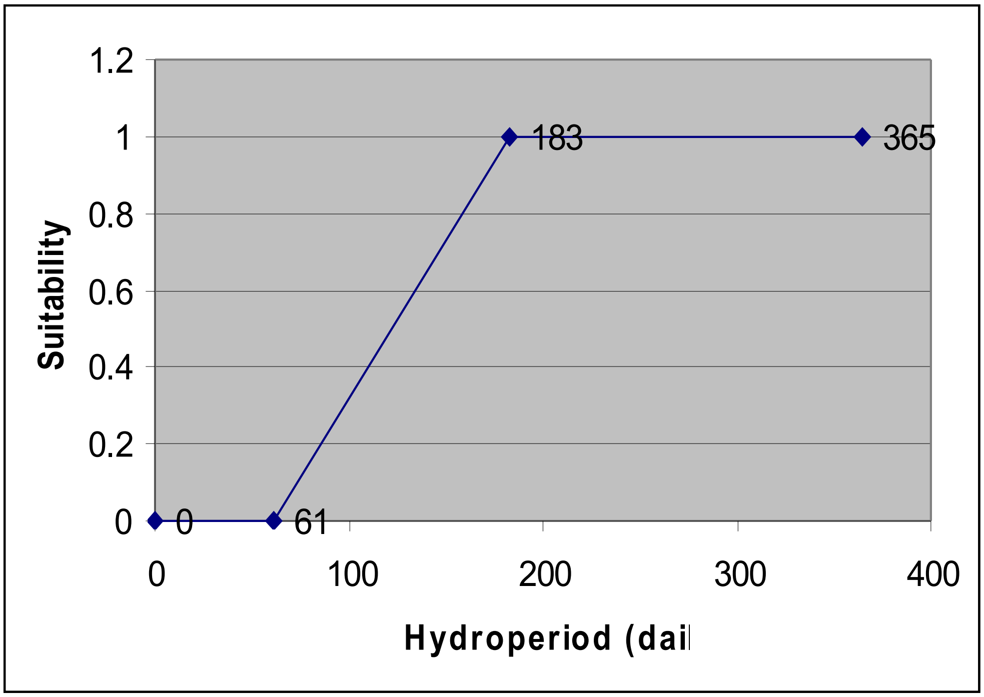
OUTPUTS

Habitat Suitability Index (HSI) values will be generated for each individual species, for each input layer, for all of the model's scenarios and sub-scenarios. An amphibian's community composite HSI is created from the product of each separate input HSI for each species, along with a species richness (see Species Richness section of document).

Output	Inputs	Time Resolution	Type of output
Hydro-period component raster for each species, for each scenario and sub scenario of every year.	Hydro-period (water depth)	Time Step	Map
Vegetation component raster for each species.	Vegetation raster	Static	Map
Salinity component raster for each species, for each scenario and sub scenario of every year.	Salinity	Time Step	Map
Hydro/Vegetation HSIs for each species, for each scenario and sub scenario of every year.	Hydro-period (water depth) & Vegetation.	Time Step	Map
Hydro/Salinity HSIs for each species, for each scenario and sub scenario of every year	Hydro-period (water depth) & Salinity	Static	Map
Composite model output HSI: hydro, salinity & vegetation	Hydro-period HSI, Vegetation HSI and Salinity HSI	Yearly	Map

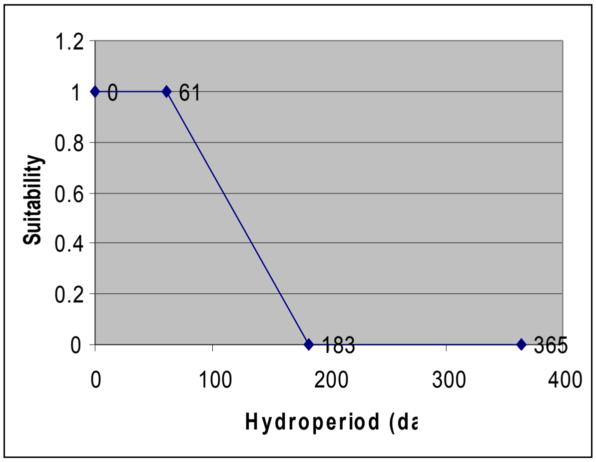
1. Hydroperiod Component

Cricket Frog Hydroperiod Component Function



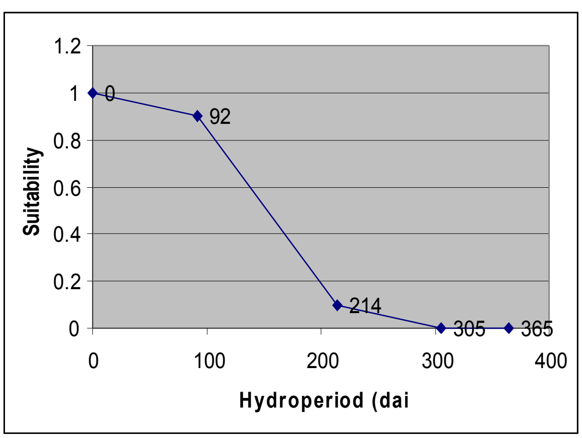
$\textit{\textbf{Hydroperiod}}_{\text{Cricket frog}}(x) = \{$	0	$0 \le x \le 61$
	$0.008x-0.5$	$61<x<183$
	1	$183 \le x$

Oak Toad, Southern Toad, Greenhouse Frog, Squirrel Treefrog and Cuban Treefrog Hydroperiod Component Function



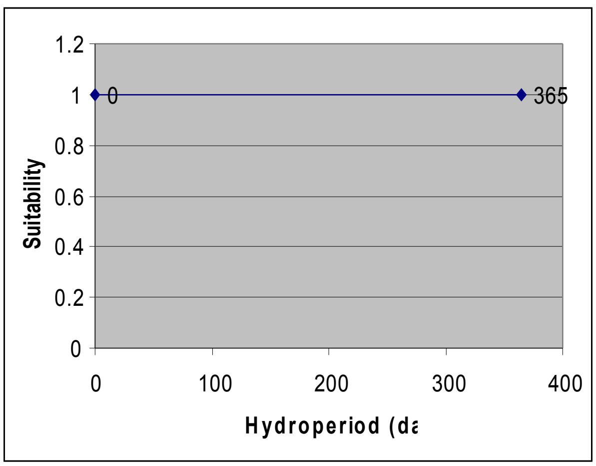
HydroperiodOak toad (x) = ***Hydroperiod***Southern toad (x) = ***Hydroperiod***Greenhouse frog (x) = ***Hydroperiod***Squirrel treefrog (x) = ***Hydroperiod***Cuban treefrog (x) =	$\{$	1	$0 \leq x \leq 61$
		$-0.008x+1.5$	$61<x<183$
		0	$x \geq 183$

Eastern Narrowmouth Toad Hydroperiod Component Function



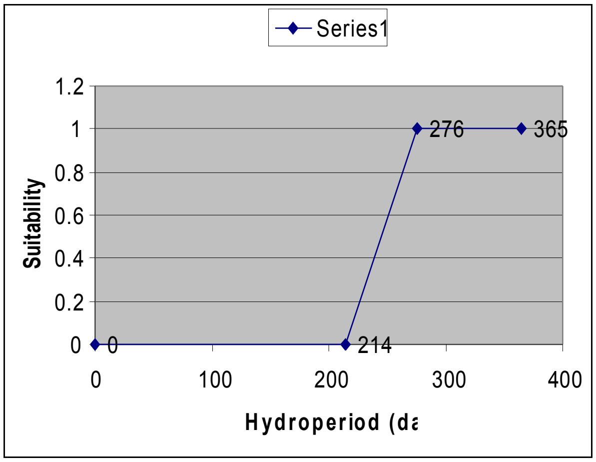
$Hydroperiod_{\text{Narrowmouth toad}}(x) = \{$	1	$x=0$
	$-0.0011x+1$	$0<x<92$
	0.9	$x=92$
	$-0.0066x+1.5$	$92<x<214$
	0.1	$x=214$
	$-0.0011x+0.333333$	$214<x<305$
	0	$x\geq305$

Green Treefrog Hydroperiod Component Function



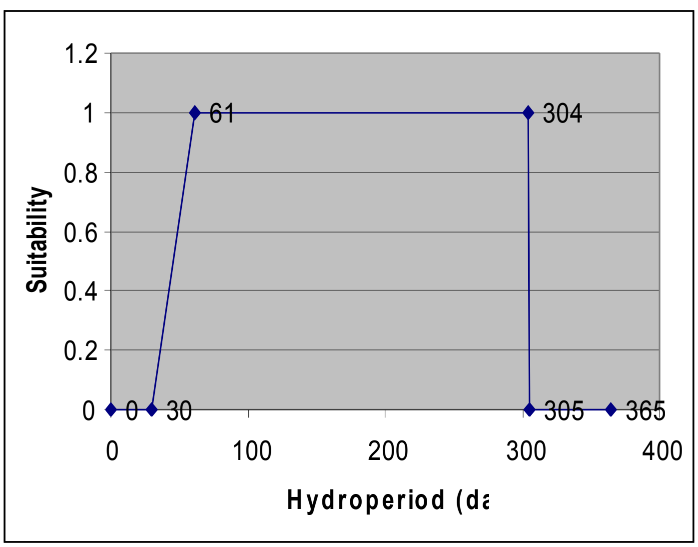
$Hydroperiod_{\text{Green treefrog}}(x) = \{$	1	$0\leq x\leq365$

Pig Frog Hydroperiod Component Function



$\textbf{\textit{Hydroperiod}}_{\text{Pig frog}}(x) = \{$	0	$0 \le x \le 214$
	$0.016x$-3	$214 < x < 276$
	1	$x \ge 276$

Leopard Frog Hydroperiod Component Function



HydroperiodLeopard frog (x) =	0	$0 \le x \le 30$
	$0.034x-1$	$30<x<61$
	1	$61 \le x \le 304$
	$-1x+305$	$304 \le x \le 305$
	0	$x>305$

2. Vegetation (Land Cover) Component
The vegetation component functions were based on a Percentage of Area Occupancy (PAO), see Note section of this document.

<u>Cricket Frog Vegetation Component Function</u>

LandCricket frog (v) =	0.9	v=4, 7 or 2 (cypress, hammock or rocky glades)
	0.5	v=8 (building)
	0	v=1 (mangrove)
	0.8	v=6 (pineland)
	1	v=3 or 5 (dwarf prairie,slough)
	0.3	v=9 (canal)

<u>Oak Toad Vegetation Component Function</u>

LandOak toad (v) =	0.1	v=4 or 7 (cypress hammock)
	0	v=1, 3 or 9 (mangrove slough)
	1	v=6 (pineland)
	0.7	v=2 (marsh/rocky glades)
	0.8	v=5 (dwarf cypress prairie)
	0.5	v=8 (building/road)

.

Southern Toad Vegetation Component Function

$\boldsymbol{Land}_{\text{Southern toad}}(v) = \{$	0.3	*v*=4, 8 or 9 (cypress, building/road, borrow pit/canal)
	0.6	*v*=7 or 2 (hammock, marsh/rocky glades)
	1	*v*=6 (pineland)
	0.5	*v*=1 or 5 (mangrove, dwarf cypress prairie)
	0.4	*v*=3 (slough)

Greenhouse Frog Vegetation Component Function

$\boldsymbol{Land}_{\text{Greenhouse frog}}(v) = \{$	0.4	*v*=4 (cypress)
	0.9	*v*=7 (hammock)
	0.5	*v*=1 (mangrove)
	0.8	*v*=6 or 5 (pineland, dwarf cypress prairie)
	0	*v*=3, 8 or 9 (slough, building, borrow pit)
	0.6	*v*=2 (marsh/rocky glades)

.

Eastern Narrowmouth Toad Vegetation Component Function

$\boldsymbol{Land}_{\text{Narrowmouth toad}}(v) = \{$	0.7	*v*=4, 7 or 2 (cypress, hammock,marsh/rocky glades)
	0.4	*v*=1 or 5 (mangrove, dwarf cypress)
	0.5	*v*=6 or 9 (pineland, borrow pit)
	0.3	*v*=3 (slough)
	0.8	*v*=8 (dwarf cypress prairie)

Green Treefrog Vegetation Component Function

LandGreen treefrog $(v) = \{$	1	v=4, 7,2,3 or 5 (cypress, hammock, marsh, slough, dwarf cypress prairie)
	0.5	v=1 (mangrove)
	0.9	v=6 (pineland)
	0.8	v=8 or 9 (borrow pit, building)

Squirrel Treefrog Vegetation Component Function

LandSquirrel treefrog $(v) = \{$	0.9	v=4 (cypress)
	0.7	v=5, 6 or 7 (dwarf cypress prairie, pineland, hammock)
	0.5	v=1 (mangrove)
	0.8	v=2(marsh/rocky glades)
	0.2	v=3 (slough)
	0.3	v=8 or 9 (borrow pit, building/road)

Cuban Treefrog Vegetation Component Function

LandCuban treefrog $(v) = \{$	0.2	v=4 (cypress)
	0.3	v=7 (hammock)
	0.6	v=1 or 6 (mangrove, pineland)
	0.08	v=2 (marsh/rocky glades)
	0	v=3 or 8 (slough, building)
	0.5	v=9 (borrow pit/canal)
	0.1	v=5 (dwarf cypress prairie)

.

Pig Frog Vegetation Component Function

$\mathbf{\mathit{Land}}_{\text{Pig frog}}(v) = \{$	0.8	v=4 (cypress)
	0.9	v=2, 5 or 7 (hammock, dwarf cypress prairie, marsh rocky)
	0.3	v=1, 6 or 9 (mangrove, pine)
	1	v=3 (slough)
	0.5	v=8 (building/road)

.

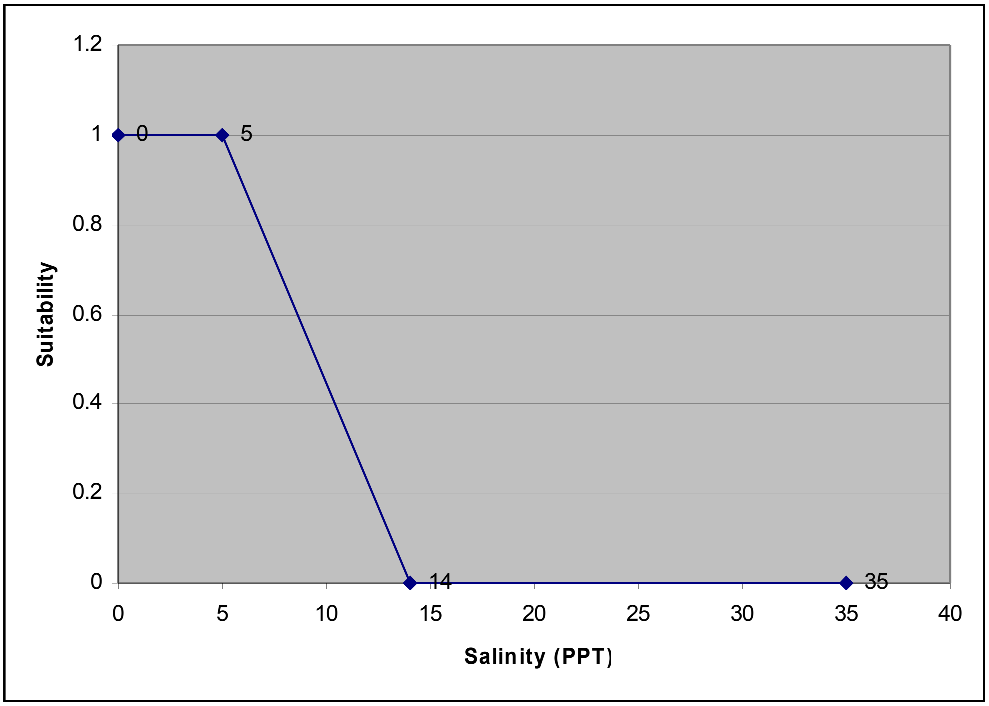
Leopard Frog Vegetation Component Function

$\mathbf{\mathit{Land}}_{\text{Leopard frog}}(v) = \{$	0.8	v=3 or 4(cypress, slough)
	0.9	v=5 or 7 (hammock, dwarf cypress)
	0.4	v=1 (mangrove)
	0.7	V=6 (pineland)
	0.5	v=8 or 9 (building, borrow pit)
	1	v=2 (marsh/rocky glades)

3. Salinity Component

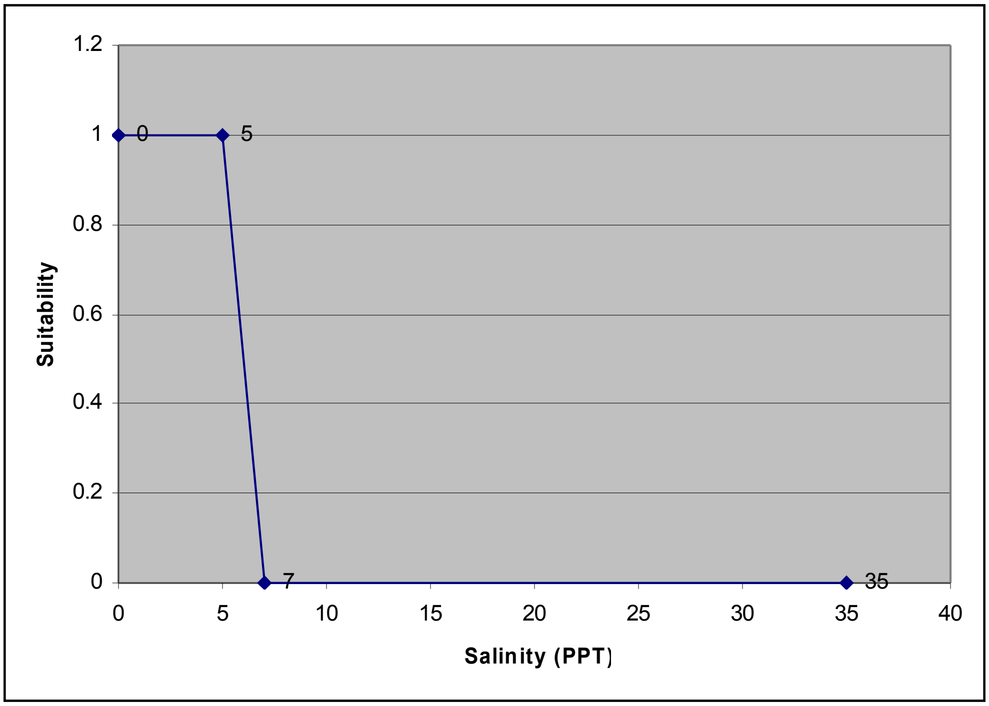
The salinity pattern component represents the relationship of the suitability index to salinity (average yearly salinity measured in PPT), which varies by species. The salinity component applies to all species in the model. The input rasters used for each salinity component, and the suitability indices for the species, are provided below.

Southern toad and Oak toad Salinity Component Function



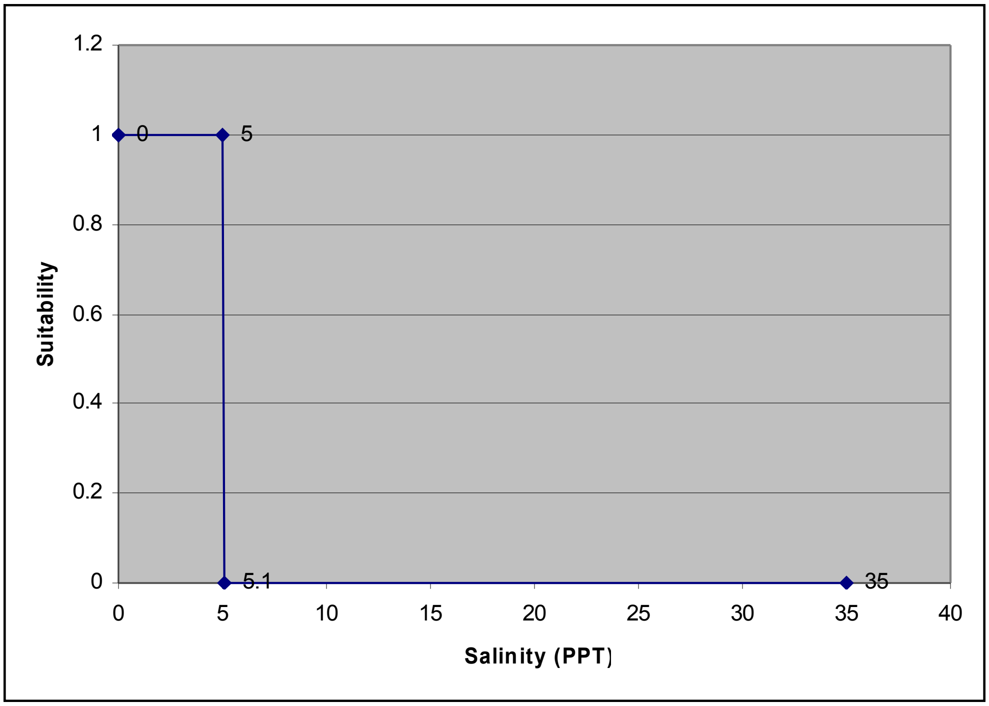
Southern toad/Oak toad (x) =		
	1	$0 \le x \le 5$
	$-0.11x+1.5$	$5<x<14$
	0	$x \ge 14$

Pig Frog and Leopard Frog Salinity Component Function



Pig Frog/Leopard Frog (x) =	1	$0 \leq x \leq 5$
	$-0.5x+3.5$	$5<x<7$
	0	$x \geq 7$

Greenhouse Frog, Squirrel Treefrog, Cuban Treefrog, Cricket Frog, Eastern Narrowmouth Toad, Green Treefrog, Barking Treefrog, and Pinewoods Treefrog Salinity Component Function



Above mentioned Species (x) = {	1	$0 \leq x \leq 4.7$
	0	$4.7 < x$

Input Data Distance Approximation

The two spatial pattern component functions involve distance from water or development (see Spatial Pattern Component section of this document). Given the spatial constraints of the input data (cell sizes of 500m by 500m.), distances are defined based on adjacency of grid cells. If a cell under consideration is adjacent to another cell (touching the cell in any direction, including diagonally), then all area within one cell is defined as being 500m from all area within the adjacent cell. Distance is estimated by approximating the number of whole grid cells that comprise that distance: for example, 500 m corresponds to one adjacent grid cell, 1 km corresponds to two adjacent grid cells, and 3 km corresponds to six adjacent grid cells.

Spatial Pattern Component

The spatial pattern component represents the relationship of the suitability index to a distance from a needed resource, which varies by species. The spatial pattern component applies to two species in the model: Green treefrog (distance from water) and Cuban treefrog (distance from development). The suitability indices for the species are provided below.

Green Treefrog Spatial Hydroperiod Component Function
The green treefrog spatial pattern component function involves distance from areas with a suitable hydroperiod for breeding. The input data for this component consists of a set of monthly rasters for each scenario, created from water depth input data, with 500m cells coded as 1 for “suitable hydroperiod” or 0 “not suitable hydroperiod”. The function has the following properties.

$$Spatial_{GreenTreefrog}(N) = \begin{cases} 0 & 500 > N \\ 1 & 500 \leq N \end{cases}$$

Where N is the distance from water in meters.

Cuban Treefrog Spatial Pattern Component Function: Distance from Development
The Cuban treefrog spatial pattern component function involves distance from development. The input data is a raster, created from the vegetation input, with cells coded as 1 (“development” if corresponding cell value of the vegetation raster has a value of 8 for building/road) or 0 (“no development” if otherwise). The function has the following properties.

$$Spatial_{CubanTreefrog}(N) = \begin{cases} 1 & N \leq 1000 \\ -0.5\mathrm{N} + 1.5 & 1000 < N < 3000 \\ 0 & N \geq 3000 \end{cases}$$

Where N is the distance from development in meters based on the Input Data Approximation section of this document.

Habitat Suitability Index

The HSI for amphibians is calculated as the product of the hydro-period, land cover and salinity component functions. To represent the suitability of habitat for amphibians throughout the Greater Everglades model area, the model generates an HSI raster yearly for every species and every scenario under consideration. If any of the component suitability indices is zero, then the entire HSI will be zero.

Species Richness

The species richness indicates the expected number of species present in each individual cell for every timestep of the composite Habitat Suitability Index. Given that we're calculating HSI values and not population presence, we're assuming a species to have a presence in a given cell if that species has an HSI value that is greater than 0.5. So, for example, if 8 different species each has an HSI value that is greater than 0.5 in a given cell, then that cell would contain a species richness value of 8, to indicate there is a likelihood of 8 different species present in that cell.

Note
The model's vegetative component functions were created from a spreadsheet containing model's PAO values. These PAO values are the averaged results of: Everglades National Park (ENP) PAO, and South West Florida (SW FL PAO) . The model's PAO values were rounded to the nearest decimal value, to create the model's vegetative component functions.